

# **Spacecraft-to-Spacecraft Radio Links Instrumentation for Planetary Gravity, Atmospheric and Surface Sciences**

**Sami W. Asmar**

Jet Propulsion Laboratory, California Institute of Technology

## **Abstract**

Traditional Radio Science techniques utilizing microwave links between spacecraft and ground stations have successfully led to numerous discoveries. However, limitations on the received Signal-Noise-Ratio or geometrical coverage necessitate alternate observation configurations and new instrumentation. Spacecraft-to-spacecraft observations have significant SNR advantage over the traditional technique and can yield considerably improved geometrical coverage. These observations have been rarely carried out before because a special receiver is required onboard the spacecraft. One type of such open-loop receiver has been utilized on GRACE and will be utilized on GRAIL for precision measurements of the gravitational fields of the Earth and the Moon, respectively. A Different receiver type is onboard the New Horizons mission for an uplink occultation of Pluto's atmosphere. Yet another prototype instrument onboard the Mars Reconnaissance Orbiter and has been used to demonstrate spacecraft-to-spacecraft radio science experiments with the Odyssey spacecraft. A new digital open-loop receiver specifically designed to meet the requirements of an occultation experiment has been prototyped for flight on the Europa Jupiter System Missions to the Jovian system, i.e., a Europa orbiter and a Ganymede orbiter. This instrument can be used to achieve multiple scientific including occultations of the atmosphere and ionosphere of Jupiter, occultations of the tenuous atmospheres and ionospheres of the Jovian satellites, occultations of the tenuous Jovian rings, and bistatic scattering from surfaces of the satellites. This paper will discuss the functional instrumentation under development as well as the potential achievable scientific investigations.